Designing Effective Assessments

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Summer Institute for

Mathematics & Science Teachers

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Developing An Assessment System
Overview

- Assessment
  - Formative & Summative
- Assessment is comprehensive
  - Assess student learning
  - Assess effectiveness of teaching
  - Assess quality of curriculum
- Assessment is on-going, evolving & changing
  - Pre-assessment
  - Assessing during the learning & teaching process
  - Post-assessment
  - Review & revision of assessment is continuous

Developing a Comprehensive Assessment System

- Align with your curriculum & standards (guidelines)
- Align with your goals & objectives
- Develop a wide variety of assessment instruments
- Align with your students' diverse learning styles
- Match assessment instruments to teaching approach
  - Individual, pair, & group assessment
  - Use graphic organizers as assessment instruments
  - Use authentic assessments that are relevant & meaningful
  - Reflection as self assessment
- Use assessment for quality control
  - improve teaching & learning

Assessing with K-W-L

I already know	I want to know	I learned that….

(Ogle, D.M. (1986). K-W-L: A teaching model that develops active reading of expository text. The Reading Teacher, 39 (6), 564-570

Developing Assessment for Improving Teaching & Learning

- **Impact of Assessment**
  - Analyze data to assess learning, teaching, & curriculum
  - Use findings to identify areas of strength & areas that need improvement
  - Make changes in planning & teaching
- **Assessment for Content-based learning & teaching**
  - Assess knowledge of content areas
  - Assess development of language skills (reading writing, listening & speaking
  - Use diverse instruments to accommodate all students
  - Change teaching approach based on assessment outcomes

Examples adapted from

Michael O'Malley &
Lorraine Valdez Pierce
Authentic Assessment for English Language Learners
Addison Wesley
1996

Developing Authentic Assessments for Content-based Learning & Teaching (Fig. 2.1)

Oral interview

Text Retelling

Writing Samples

Projects / Exhibitions

Experiments / Demonstration

Open-ended Questions

Observations

Portfolios

When would you use these assessment (pre-/post/during)?

Developing Rubrics

Figures 2.5 & 7.10

Develop collaboratively with students

Rubric development increase students' understanding of how to achieve proficiency

"Unpacks" proficiencies & strategies

Choice of descriptors

Emerging - Proficient

Where would most students be?

Outstanding

Unacceptable

Assessing Cognitive Skills Across Content Areas

(Fig. 7.6)

Assessing Effective Use

of

Learning Strategies

(Fig. 4.2)

Scaffold Assessments

to

Help Students Succeed

(Fig. 7.1)

Assessment Examples	Without Scaffolding	With Scaffolding
Write a word problem	Create a word problem from own numbers, give equation, story, & question	Given example and an outline of a sample problem **Complete a word problem**
Summarize a science experiment	Write a summary of procedures in a science experiment following scientific principles	Given a list of procedures in science experiments including questions, materials, a plan for observations, & conclusions **Complete a summary** **Demonstrate the steps using actual materials**
Retell or summarize text	Write 5 main ideas from an article & give examples	**Complete an outline, a list, or a semantic map**

Self Assessment & Reflection

- Important for effective teaching
- Use regularly & model for students
- Encourage students to self assess regularly & to think about their own performance
- Use reflective journals
- Develop a rubric with students for self assessment tasks
- Reflect on quality of homework using a rubric

Self Assessment for

an Oral Report

Fig. 4.15

Standards (Guidelines)

NCTE

National Council for Teachers of English

NCTM

National Council of Teachers of Mathematics

NSTA

National Science Teachers Association

Web Resources for

Standard-based Lessons

www.figurethis.org

NCTM ILLUMINATIONS marcopolo

Illuminating NCTM's Vision for School Mathematics

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Explore our library of 72 online activities that help to make math come alive in the classroom or at home

Lessons

View our collection of 507 lessons for preK-12 math educators

Standards

Learn about NCTM's *Principles and Standards for School Mathematics*

Web Links

Check out hundreds of exemplary online resources, as identified by an editorial panel

Highlighted Activity

State Data Map

3–12

Representing Numerical Information

State data is represented visually—each state is colored proportionally to its data value. Students can choose from pre-loaded sets about area, population, and gas usage, or they can enter their own data.

Highlighted Lesson

The Game of SKUNK

6–8

Understanding Choice and Chance

While playing a game involving probability, students develop decision-making skills.

Professional Development

Got an Idea Worth Sharing?

Submit an article:

- Mathematics Teacher
- Math Teaching in the Middle School
- Teaching Children Mathematics
- ON-Math

Or send us your ideas for an Illuminations lesson plan.

2006-07 Lesson Study

Participate in a year-long lesson study. This **three-credit graduate course** begins with a face-to-face meeting in August and continues with online meetings throughout the year.

2005-06 Focus of the Year

"Assessing to Learn and Learning to Assess"

Illuminations Site Redesign

In January, Illuminations got a new look. Watch this Flash movie to see what's new! (Requires Flash Player 8.)

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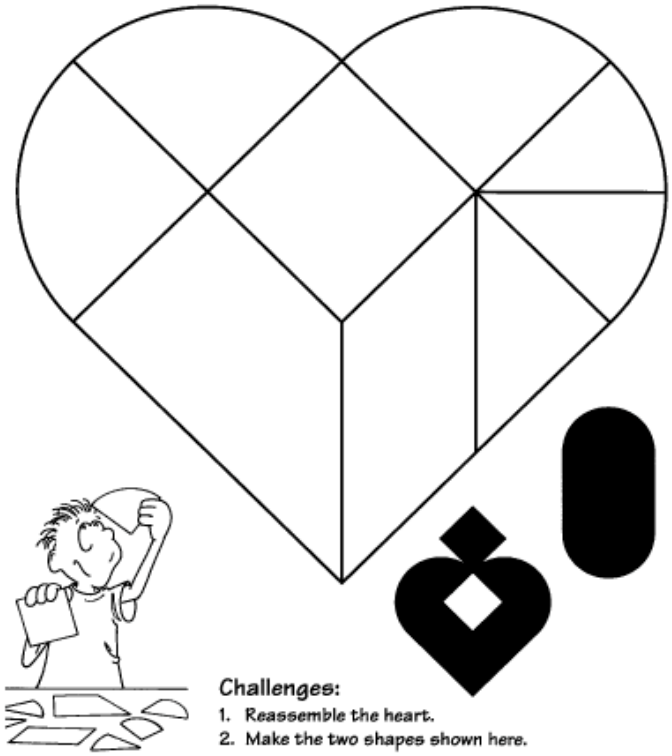
The Heart Breaking Puzzle

Carefully cut out the pieces of the heart puzzle. Use all nine pieces to make as many interesting shapes as you can. (The pieces must be placed edge to edge and can't overlap.) Make a record of your shapes by drawing their outlines on a separate sheet of paper.

Challenges:

1. Reassemble the heart.
2. Make the two shapes shown at bottom right.



Challenges:
1. Reassemble the heart.
2. Make the two shapes shown here.

AIMS Education Foundation

Activities Integrating Mathematics & Science

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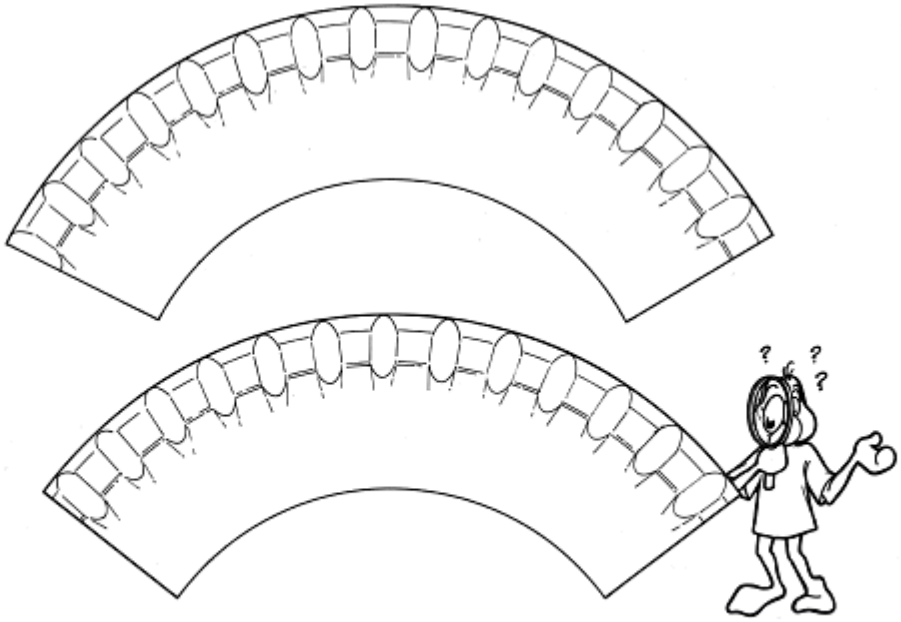
There's More Than Meets The Eye

Look at the two arcs. What is their apparent size relationship?
Cut out the arcs and reverse their positions.
What happens?
Experiment with the arcs and see what else you discover. Write about your discoveries.



Overview: Standards for Grades 9 – 12

In secondary school, all students should learn an ambitious common foundation of mathematical ideas and applications. This shared mathematical understanding is as important for students who will enter the workplace as it is for those who will pursue further study in mathematics and science. All students should study mathematics in each of the four years that they are enrolled in high school.

Because students' interests and aspirations may change during and after high school, their mathematics education should guarantee access to a broad spectrum of career and educational options. They should experience the interplay of algebra, geometry, statistics, probability, and discrete mathematics. They need to understand the fundamental mathematical concepts of function and relation, invariance, and transformation. They should be adept at visualizing, describing, and analyzing situations in mathematical terms. And they need to be able to justify and prove mathematically based ideas.

High school mathematics builds on the skills and understandings developed in the lower grades. For example, students should enter high school with extensive experience in modeling various patterns and relationships. High school students might explore the following problem:

Geometry Standard for Grades 9 – 12

Expectations

Instructional programs from prekindergarten through grade 12 should enable all students to—	In grades 9 – 12 all students should—
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships	• analyze properties and determine attributes of two- and three-dimensional objects; • explore relationships (including congruence and similarity) among classes of two- and three-dimensional geometric objects, make and test conjectures about them, and solve problems involving them; • establish the validity of geometric conjectures using deduction, prove theorems, and critique arguments made by others; • use trigonometric relationships to determine lengths and angle measures.
Specify locations and describe spatial relationships using coordinate geometry and other representational systems	• use Cartesian coordinates and other coordinate systems, such as navigational, polar, or spherical systems, to analyze geometric situations; • investigate conjectures and solve problems involving two- and three-dimensional objects represented with Cartesian coordinates.
Apply transformations and use symmetry to analyze mathematical situations	• understand and represent translations, reflections, rotations, and dilations of objects in the plane by using sketches, coordinates, vectors, function notation, and matrices; • use various representations to help understand the effects of simple transformations and their compositions.

Geometry Standard for Grades 6 – 8

Expectations

Instructional programs from prekindergarten through grade 12 should enable all students to—	In grades 6 – 8 all students should—
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships	• precisely describe, classify, and understand relationships among types of two- and three-dimensional objects using their defining properties; • understand relationships among the angles, side lengths, perimeters, areas, and volumes of similar objects; • create and critique inductive and deductive arguments concerning geometric ideas and relationships, such as congruence, similarity, and the Pythagorean relationship.
Specify locations and describe spatial relationships using coordinate geometry and other representational systems	• use coordinate geometry to represent and examine the properties of geometric shapes; • use coordinate geometry to examine special geometric shapes, such as regular polygons or those with pairs of parallel or perpendicular sides.
Apply transformations and use symmetry to analyze mathematical situations	• describe sizes, positions, and orientations of shapes under informal transformations such as flips, turns, slides, and scaling; • examine the congruence, similarity, and line or rotational symmetry of objects using transformations.
Use visualization, spatial reasoning, and geometric modeling to solve problems	• draw geometric objects with specified properties, such as side lengths or angle measures; • use two-dimensional representations of three-dimensional objects to visualize and solve

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TERC's work in mathematics and science education includes research, curriculum and technology development, and implementation support, including professional development and assistance to districts and schools. Our programs span pre-kindergarten through college and include adult basic education and informal learning at museums, at home, and in afterschool programs. Research drives the creation of our activities and products. We also seek to create new knowledge about science and math learning and teaching through research.

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- Adult Numeracy
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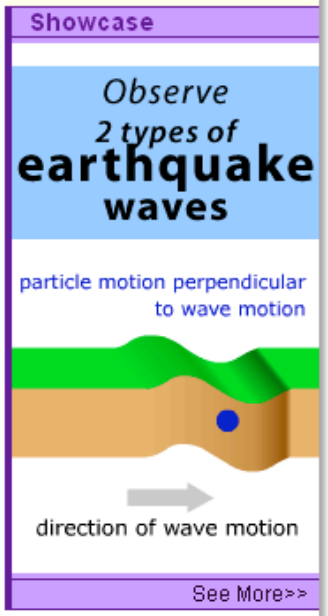

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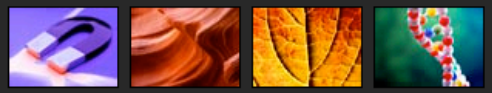

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News

U.S. Earns a C in Technology
NSTA-Kristin Collins

Forum to Tackle Intelligent Design
Tallahassee Democrat (Florida)

Chimpanzee and Human Ancestors May Have Interbred
Nature News

More News

Today in science history

On May 17 in 1883, in a flash during a fit of sleeplessness, Swedish chemistry student Svante Arrhenius, 24, is hit with his "dissociation theory" (which states that a substance like salt dissolves into electrically charged ions when added to water) to explain numerous experiments/data he was contemplating. At the time the theory was highly controversial and earned Arrhenius the lowest possible passing grade for his doctoral thesis. This theory is now accepted as fact, and its creator eventually won the Nobel Prize. [from *The Illustrated Almanac of Science, Technology, and Invention*]

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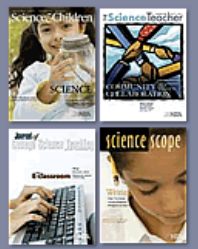

[more]

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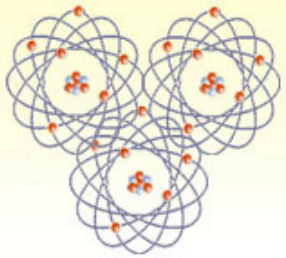
Benchmarks Index



About the Benchmarks

To help educators integrate Science NetLinks resources into a standards-based curriculum, all site content is organized around the Benchmarks for Science Literacy. These benchmarks are a set of science literacy goals developed through Project 2061, AAAS's long-term initiative to reform K-12 science education. More on Benchmarks...

How to use the Benchmarks Index...

To view the learning goals in a particular benchmark chapter, click on the desired grade level box in the right column of the table.

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1. The Nature of Science How science works	K-2 3-5 6-8 9-12
2. The Nature of Mathematics Mathematics as part of the scientific endeavor	K-2 3-5 6-8 9-12
3. The Nature of Technology General principles of technology and engineering	K-2 3-5 6-8 9-12
4. The Physical Setting The makeup and structure of the universe	K-2 3-5 6-8 9-12
5. The Living Environment How living things function and interact	K-2 3-5 6-8 9-12
6. The Human Organism The biology of humans	K-2 3-5 6-8 9-12
7. Human Society Social behavior of individuals and groups	K-2 3-5 6-8 9-12
8. The Designed World Key technologies that shape our world	K-2 3-5 6-8 9-12
9. The Mathematical World Basic mathematical ideas	K-2 3-5 6-8 9-12
10. Historical Perspectives Key episodes in the history of science	K-2 3-5 6-8 9-12
11. Common Themes Crosscutting themes and ideas	K-2 3-5 6-8 9-12
12. Habits of Mind Values, skills, and attitudes	K-2 3-5 6-8 9-12

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6-8

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Choose a Grade and Choose a Benchmark Display

Benchmark 1

Nature of Science

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Reviewed Sites

4000 Years of Women in Science

Considering that modern American society has only truly acknowledged the legitimacy of women in sciences for say, the last twenty years, a website on 4000 years of women in science is truly an inspiration!

About Rainbows

This site is a tutorial developed by Beverly Lynds, co-PI for Project Skymath of the University Corporation for Atmospheric Research. The images and charts that are provided help to clarify the description, and really bring the words to life.

Annenberg/CPB

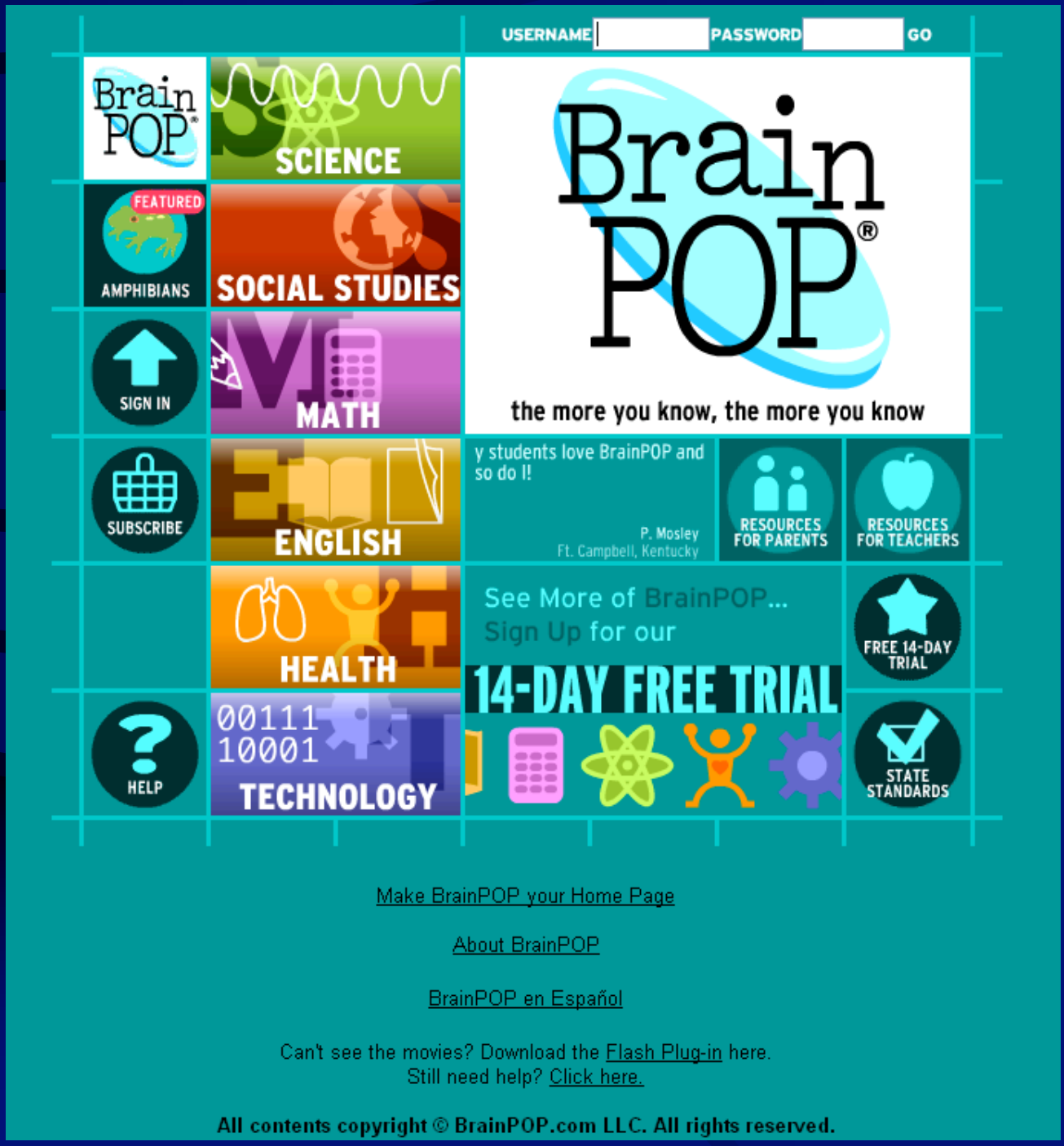
This is the essential website for educators, parents, librarians, and students.

Boston Museum of Science

The Boston Museum of Science (MOS) has something for everyone.

BrainPOP

This site can stimulate independent learning and creativity in students, while it provides teachers with new ideas for their classes. BrainPOP is a first-rate, fun learning experience for visitors.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HOW THE WORLD WORKS

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Math

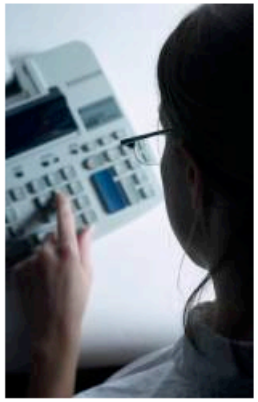
Use links on right for key ideas, performance indicators and aligned MarcoPolo Lessons for each learning standard.

MST Standard Three: Mathematics

Students will:

- understand the concepts of and become proficient with the skills of mathematics;
- communicate and reason mathematically;
- become problem solvers by using appropriate tools and strategies;

through the integrated study of number sense and operations, algebra, geometry, measurement, and statistics and probability.



Instructionally, there are three components underpinning the revised Learning Standards for Mathematics:

- **Conceptual Understanding**, involving the understanding of mathematical ideas and procedures. This includes the knowledge of basic arithmetic facts. This component serves to lay the foundation for "remembering or reconstructing mathematical facts and methods, for solving new and unfamiliar problems, and for generating new knowledge".
- **Procedural Fluency**, that is, the ability to carry out procedures "flexibly, accurately, efficiently and appropriately", and
- **Problem Solving**, the "ability to formulate, represent, and solve mathematical problems".

These components are represented as content and process strands in the revised standards, which are grade-specific.

The five content strands are: number sense and operations, algebra, geometry, measurement, and statistics and probability. Within each of these strands are bands which focus instruction into specific areas for study, such as Estimation in the Number Sense and Operations strand.

The five process strands are problem solving, reasoning and proof, communication, connections, and representation.

Math by Grade

PreK Math
Kindergarten Math
Grade 1 Math
Grade 2 Math
Grade 3 Math
Grade 4 Math
Grade 5 Math
Grade 6 Math
Grade 7 Math
Grade 8 Math
Algebra
Geometry
Algebra 2 & Trig

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Lesson Details

Lesson Information

Lesson Title: Exploring Pendulums

Grade Level (s): 6,7,8

Lesson URL: http://www.sciencenetlinks.com/Lessons.cfm?DocID=179

Description: In this Science NetLinks lesson, students will explore websites with simulations of pendulums, where they'll be able to change the length and angle of the bob and observe its effects. They will then construct and test their own controlled-falling systems, or pendulums, to further observe and verify these theories. This lesson helps students understand concepts related to how gravitational forces act on objects by exploring the motion of pendulums.

Teacher Ratings: Not yet rated. View ratings and comments Rate this lesson!

Partner Information

Partner Name: ScienceNetLinks

NY State Standards Alignments:

Subject	Grade or Level	Learning Standard or MST Math Strand or ELA Literacy Competency	Key Idea or MST Math Band or ELA Competency Skill	Performance Indicator or ELA Competency Indicator
Science	Intermediate	*Standard 4* - Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.	*Physical Setting* Energy and matter interact through forces that result in changes in motion.	Students describe different patterns of motion of objects.
Science	Intermediate	*Standard 4* - Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.	*Physical Setting* Energy and matter interact through forces that result in changes in motion.	Students observe, describe, and compare effects of forces (gravity, electric current, and magnetism) on the motion of objects.

Web Resources for Teachers

- http://mathforum.org/trscavo/tangrams/tangram-pieces.html
- http://www.aimsedu.org/Puzzle/Heart/heart2.html
- http://www.aimsedu.org/Puzzle/MoreNEye/arcs2.html
- http://illuminations.nctm.org/
- http://standards.nctm.org/document/chapter7/index.htm
- http://standards.nctm.org/document/chapter6/geom.htm
- http://www.terc.edu/ourwork/
- http://www.sciencenetlinks.com/benchmark_index.htm
- http://www.sciencenetlinks.com/resources_list.cfm?Grade=6-8&BenchmarkID=1
- http://www.brainpop.com/
- http://www.brainpop.com/science/seeall/
- http://www.lhs.berkeley.edu./

Additional Web Resources for Teachers

- http://www.nsta.org/
- http://standards.nctm.org/document/chapter7/geom.htm
- http://www.nyiteez.org/MarcoPoloNY/index.php
- http://www.nyiteez.org/MarcoPoloNY/NYSS_Math.php
- http://www.nyiteez.org/MarcoPoloNY/ProgramDetail.php?CourseID=SN017922
- http://www.physics.uoguelph.ca/applets/Intro_physics/kisalev/java/pend1/index.html
- http://www.ipl.org/div/kidspace/projectguide/

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